REMARKS

Status of Claims

Claims 1- 4, 8-13, 15-16, 20-24 are pending.

Claims 5-7, 14, and 17-20 are canceled.

Claims 23 and 24 are new. These new claims find support at least in paragraphs [0014] and [0019] of the specification as filed.

Interview Summary

Applicant wishes to thank the Examiner for the telephone interview of December 29, 2009 between the Examiner and the undersigned Vernon Maine and Douglas Burum, during which time strategies were discussed regarding approaches for bringing the case into condition for allowance. In particular, Applicant is grateful for the Examiner's suggestion that the invention could be better distinguished from prior art directed to non-thermal imaging by clarifying in the independent claims that the FPA is able to detect infra-red radiation emitted by the lens as well as by the black body scene, and that the infra-red radiation emitted by the lens must therefore be included in the "closed state image" so as to properly correct the "open state image." This amendment is supported for example in the specification at paragraph [0029]. Applicant is also grateful for the Examiner's suggestion to claim a specific distance between the shutter and the lens. This amendment is supported in the specification for example by paragraphs [0014] and [0019]. Applicant has herein amended claims 1, 10, and 15 and added new claims 23 and 24 in accordance with the Examiner's suggestions. Applicant thanks the Examiner for his time and guidance.

Summary of Applicant's Position

Applicant incorporates by reference its comments from its prior written correspondences and the telephone interviews of April 10, September 2, and December 29, and comments further as follows.

It is fundamental to the present invention that the claimed thermal imaging system is configured to form an image of detected infra-red radiation emitted by a black body scene, that the thermal imaging system includes a shutter, a lens, and a focal plane array, or "FPA," and that the shutter is located between the black body scene and the lens, and not between the lens and the FPA. In contrast, at the time of the invention, all known prior art thermal imaging systems, according to conventional wisdom in the art at that time, placed the shutter between the lens and the FPA.

The present invention was enabled by the discovery of two sources of background noise error in thermal imaging systems that were not previously understood, both of these sources of background noise being addressed in the present invention by proceeding against conventional wisdom and placing the shutter between the lens and the black body scene, rather than between the lens and the FPA.

The first source of background noise discovered by the inventors is infra-red radiation emitted by internal components of the imaging system, notably the lens, and detected by the FPA. This source of background noise is sometimes referred to in the specification as "internal flux." See for example paragraphs [0005], [0010], [0012], [0029], and [0036] in the specification.

The second source of background noise arises from a variation in the infra-red radiation emitted by the shutter and detected by the FPA, the variation being due to the change in the shutter's physical configuration between its open state and its closed state. See, for example, paragraphs [0027] – [0028] and [0031] in the specification. This effect can be visualized in a very simple way by imagining that well focused IR images of the shutter are obtained by the FPA in the closed and open states, whereby

one of these images shows the shutter open, and the other shows the shutter closed. In this imaginary scenario, it is obvious that subtracting the closed state image from the open state image would not fully cancel the image of the shutter, since an image of the closable iris would remain, and this would serve as an artifact in the corrected image. In reality, the IR from the shutter is not focused into an image on the FPA, but the principle remains the same. Changes in the shutter's physical configuration lead to incomplete correction of shutter IR artifacts in the final image.

The present invention addresses both of these sources of background noise by placing the shutter between the lens and the blackbody scene, rather than between the lens and the FPA. The first source of background noise is addressed by allowing infra-red radiation emitted by the lens to be included in the closed-shutter reference image so that it can be subtracted from open shutter images. The second source of background noise is addressed by locating the shutter further from the FPA, thus diminishing the magnitude of detected infra-red radiation from the shutter due to the increased distance.

The office action of October 27, 2009 rejected all pending claims under 35 USC 103(a) due to Lindgren in light of Bakhle. However, since neither Lindgren nor Bakhle teaches a shutter between the lens and the scene, the present invention cannot be obvious in light of any combination of Lindgren and Bakhle. However, during the interview of December 29, the Examiner suggested that the present invention could be considered obvious due to a combination of Lindgren with some other reference, such as previously cited Medina, directed to non-thermal imaging systems such as optical video cameras.

However, all claims of the present application are currently amended so as to require that the system be capable of detecting infra-red radiation emitted by the lens when the shutter is closed. This limitation necessarily requires two features. First, the shutter must be positioned such that infra-red radiation emitted by the lens is able to reach the FPA when the shutter is closed. Second, the detector (i.e. FPA or equivalent) must have sufficient sensitivity to detect the infra-red radiation emitted by the lens. No

cited prior art teaches both of these features in combination, and so no cited prior art teaches this limitation. While the detector of Lindgren may have sufficient sensitivity, no shutter is taught. Other thermal imaging prior art references that may have sufficient detector sensitivity position the shutter so as to prevent infra-red radiation emitted by the lens from reaching the detector when the shutter is closed. Prior art directed to non-thermal imaging systems lack the required detector sensitivity, and so cannot detect infra-red radiation emitted by the lens at any time, whether or not the shutter is closed, and no matter where the shutter is located. Since no cited prior art reference teaches the limitation that the system be capable of detecting infra-red radiation emitted by the lens when the shutter is closed, no combination of the teachings of these references can teach this limitation.

It is therefore Applicant's position that a prima-facia case of obviousness has not been established regarding any of the pending claims of the present invention, and cannot be established using any combination of the prior art references already cited, because no prior art has been cited that teaches a device or method that can detect infra-red radiation emitted by the lens when the shutter is in a closed state, as required by all pending claims as currently amended.

The Applicant further asserts that even if a prima-facia case of obviousness were somehow to be established, the present invention cannot be obvious because the present invention is a patentable invention that lies at least in part in the discovery of the source of a problem, as per MPEP 2141.02, subsection III.

The Applicant further asserts that even if a prima-facia case of obviousness were to be established, the present invention cannot be obvious because the inventors have "proceeded contrary to accepted wisdom" as per MPEP 2145, subsection 3. MPEP 2145 also states in part that a rebuttal of an obviousness rejection may include **evidence of "the beliefs of those skilled in the art."** See, e.g., *Beattie*, 974 F.2d at 1313, 24 USPQ2d at 1042-43 (Seven declarations provided by music teachers opining that the art teaches away from the claimed invention must be considered).

An affidavit according to 17 CFR 1.132 is submitted herewith as evidence that the conventional wisdom in the art at the time of the invention placed the shutter between the lens and the FPA, and that the above-mentioned sources of background noise were not understood at that time in the art.

For the convenience of the Examiner, the above referenced sections of the MPEP are reproduced here:

MPEP 2141.02, subsection III :

III. DISCOVERING SOURCE/CAUSE OF A PROBLEM IS PART OF "AS A WHOLE" INQUIRY

"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

MPEP 2145 Subsection 3:

3. Proceeding Contrary to Accepted Wisdom Is Evidence of Nonobviousness

The totality of the prior art must be considered, and **proceeding contrary to accepted wisdom in the art is evidence of nonobviousness.** *In re Hedges,* 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986) (Applicant's claimed process for sulfonating diphenyl sulfone at a temperature above 127°C was contrary to accepted wisdom because the prior art as a whole suggested using lower temperatures for optimum results as evidenced by charring, decomposition, or reduced yields at higher temperatures.).

> Furthermore, "[k]nown disadvantages in old devices which would naturally discourage search for new inventions may be taken into account in determining obviousness." *United States v. Adams,* 383 U.S. 39, 52, 148 USPQ 479, 484 (1966).

The present invention was conceived under circumstances that are strikingly similar to the scenarios described in these subsections. The accepted wisdom in the art of thermal imaging systems at the time of the invention was to place the shutter adjacent to the FPA (i.e. between the lens and the FPA). This was for several practical reasons. Thermal imaging systems at that time were commonly cryogenically cooled, and the lens was optically confined within the cooling envelope. Therefore, infra-red black body radiation emitted by the lens was minimal, and the shutter was used mainly to provide calibration imagines that would correct for non-linearities and imperfections in the FPA itself. There was room between the lens and the FPA for the shutter, and placement of the shutter there kept the shutter relatively small. Therefore, the conventional configuration of placing the shutter between the lens and the FPA made sense at the time.

When digital image correction became more sophisticated due to advances in computing technology, and with improvements in detector technology, it was found that cryogenic cooling was no longer necessary. However, it remained the accepted wisdom in the art to place the shutter between the lens and the FPA. It was not recognized at that time by those of ordinary skill that infra-red radiation emitted by the lens was a source of image distortion in cooled systems. It was also not realized by those of ordinary skill in the art that a variation in the infra-red radiation emitted by the shutter was caused by the change in shutter configuration between a closed and an open state, and that this variation was detectable by the FPA as a source of background noise. The present invention was enabled by the discovery of these sources of background noise by the inventors, and the consequent impetus to proceed against the accepted wisdom of the art and place the shutter between the lens and the scene, rather than between the lens and the FPA.

Claim Rejections – 35 USC § 103

Claims 1-4,8-13, 15-16,21-22 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Lindgren et al. US (5,420,421) in view of Bakhle et al. (US 6,061,092).

Applicant has carefully considered the Office rejections and respectfully submits that the currently amended claims, as supported by the comments above and the arguments herein, are distinguishable from the cited references.

Regarding claim 1, the Examiner has stated that Lindgren et al. discloses an imaging system comprising: a thermal imaging based system (infrared imaging device 10, figure 1, see abstract, Page 3 column 4, lines 12-26) adapted for imaging infra-red radiation that is emitted by a black body, the thermal imaging based system comprising: focal plane array (FPA) having a plurality of pixels sensitive to infra-red radiation (focal plane array 16, figure 1, column 3, lines 30-47; column 4, lines 12-26); a lens (optical system 12, figure 1, column 3, lines 30-47) disposed between the black body and the FPA and adapted to focus the infra-red radiation emitted by the black body in front of the lens onto the FPA behind the lens, the plurality of pixels of the FPA having sufficient infra-red sensitivity so as to detect the infra-red radiation; a signal processing module (electronics unit 18, figure 1, column 3, lines 40-53) operatively coupled to the FPA.

The Examiner has admitted that Lindgren et al. fails to specifically disclose a shutter located between the thermal imaging based system and the black body, the shutter having a closed state and an open state wherein the closed state prevents the infra-red radiation emitted by the black body from entering the thermal imaging based system, and allows internal radiant flux of the thermal imaging based system to reach the plurality of pixels of the FPA as a reference image signal, and the open state allows an open state image signal that includes both the infra-red radiation emitted by the black body and the internal radiant flux of the thermal imaging based system to reach the

plurality of pixels of the FPA; and a signal processing module operatively coupled to the FPA, and adapted to correct the open state image signal based on the reference image signal. However, the Examiner has stated that Bakhle et al. discloses a digital camera system 10, the digital camera 10 comprises a shutter (shutter 12, figures lA-IB, column 1, line 50 - column 2, line 13; the shutter is located between the CMOS image sensor array 18 and a scene in front oflens 16), the shutter having a closed state and an open state wherein the closed state prevents the radiation from the scene from entering the system, and allows internal radiant flux of the imaging system to reach detectors of the FPA as a reference image signal and the open state that allows an open state image signal that includes the radiation from the scene and the internal radiant flux of the system to enter the system and reach detectors ofthe FPA; a signal processing module (dark image subtraction unit 22, figures lA-IB, column 1, line 50 - column 2, line 13) operatively coupled to the FPA, and adapted to correct the open state image signal based on the reference image signal. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the device in Lindgren et al. by the teaching of Bakhle et al. in order to provide non-uniformity compensation for infrared focal plane array response over a wide dynamic range of signal flux levels of infrared radiation, such as a "cold" sky and "hot" terrain (column 2, lines 55-59).

It is fundamental to the present invention that the shutter is located between the lens and the black body scene, and not between the lens and the focal plan array (FPA). This limitation is included in all pending claims of the present application. Lindgren does not teach a shutter of any kind, and Bakhle teaches only a shutter located between the lens and the FPA. Consequently, none of the claims of the present invention can be obvious in light of any combination of Lindgren and Bakhle. Applicant therefore asserts that the rejection of claim 1 under 35 USC 103(a) should be withdrawn, and respectfully requests reconsideration thereof.

In the interview of December 29, 2009, the examiner suggested that the present invention might be obvious due to a combination of Lindgren and a previously cited

reference directed to a system that images visible light, such as Medina. In that regard, Applicant notes that the present invention is specifically applicable to thermal imaging systems that detect infra-red radiation emitted by black bodies. Black body infra-red radiation is naturally emitted by all physical objects at all times due to their thermal energy. However, black body radiation is normally difficult to detect in the presence of much more intense reflected energy, unless the physical object to be imaged is not illuminated by any external source and is therefore not reflecting any energy, i.e. it is a "black" body.

Thermal imaging systems face a unique problem in this regard, since the internal components of the imaging system are themselves physical objects that emit "black body" infra-red radiation. Since it is necessary for the detector (i.e. the "focal plane array" or FPA") of a thermal imaging system to have sufficient sensitivity to detect black body infra-red radiation emitted by a distant scene, the FPA will typically also detect black body infra-red radiation emitted from components within the imaging system, notably the lens, the shutter, and even the FPA itself. In fact, this "internal radiant flux" of the imaging system itself is typically an order of magnitude greater than the sensed infra-red radiation emitted by the black body. This internal radiant flux will therefore potentially distort thermal images of external black bodies obtained by the thermal imaging system.

Thermal images can be corrected by including a shutter and by obtaining a reference image with the shutter closed, which is then used to correct images obtained with the shutter open. However, this approach cannot correct for sources of image distortion that arise from elements that are blocked from the FPA by the shutter. This approach also cannot correct for changes in the infra-red radiation emitted by the shutter itself due to differences in physical configuration of the shutter between the shutter-open and shutter-closed states.

These problems and their solutions are unique to thermal imaging systems. All claims of the present application are currently amended so as to require that the infra-

red radiation emitted by the lens must be detectable by the FPA when the shutter is in the closed state. This limitation is not taught by any references cited in the office action of October 27, nor by any of the references cited in previous office actions in this case. In particular, while Medina and similar references directed to imaging of visual light may by chance place the shutter between the lens and the scene, these references do not provide a detector that is capable of detecting black body infra-red radiation, and therefore these references do not teach a system that can detect infra-red radiation emitted by the lens when the shutter is closed.

Put another way, a basic difference between the Applicant's invention and references such as Bakhle that are directed to non-thermal imaging systems is that for Bakhle's CMOS devices, which detect reflected radiation, the dominant source of noise is the Dark Fixed Pattern Noise (DFPN) inherent to the detector array. These systems are therefore incapable of detecting infra-red radiation emitted by the lens and other internal components of the system, and the precise location of the shutter in relation to the lens and other elements of the imaging system of Bakhle is therefore unimportant. A similar argument holds for Medina and other previously cited references directed to non-thermal imaging systems.

Regarding claim 2, the Examiner has stated that Bakhle et al. discloses a shutter controller (solenoid 14, figures lA-1B) operatively coupled to the shutter, and adapted to command the shutter to its opened and closed states.

However, claim 2 is dependent on claim 1, and since as demonstrated above claim 1 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 2 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 2 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 3, the Examiner has stated that Bakhle et al. discloses a system controller communicatively coupled to the shutter controller and the signal processing

module, and adapted to control operation of the imaging system (a system controller is included in digital camera 10 to control operation of digital camera 10, figures lA-1B).

However, claim 3 is dependent on claim 2, and since as demonstrated above claim 2 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 3 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 3 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 4, the Examiner has stated that Bakhle et al. discloses the system controller is communicatively coupled to a network thereby enabling the imaging system to communicate with other systems also communicatively coupled to the network (Bakhle et al. discloses video camera is coupled to a personal computer through a bus interface, column 2, lines 15-28).

However, claim 4 is dependent on claim 3, and since as demonstrated above claim 3 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 4 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 4 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 8, the Examiner has stated that Bakhle et al. discloses wherein for anyone session of imaging system operation, each of a plurality of open state image signals are corrected for pixel-to-pixel nonuniformities and offset based on the open and closed state image signal (column 1, line 50 - column 2, line 28).

However, claim 8 is dependent on claim 1, and since as demonstrated above claim 1 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 8 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 8 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 9, the Examiner has stated that Bakhle et al. discloses wherein the closed state image signal is periodically generated to account for changes in the imaging system (column 7, lines 19-28).

However, claim 9 is dependent on claim 1, and since as demonstrated above claim 1 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 9 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 9 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 10, the Examiner has stated that claim 10 is a method claim of apparatus claim 1; therefore, the Examiner has referred to his comments regarding claim 1.

However, claim 10 as currently amended requires the steps of "closing the shutter so that the infra-red radiation emitted by the black body is blocked from reaching the FPA;" and "generating a closed state image signal that includes the infra-red radiation emitted by the lens." As discussed above, Lindgren does not include a shutter, and while Bakhle includes a shutter, it is located between the lens and the detector, and would therefore prevent infra-red radiation emitted by the lens from reaching the detector when the shutter is in a closed state. Also, Bakhle is directed to a system that images visible, reflected light, and therefore could not generate "a closed state image signal that includes the infra-red radiation emitted by the lens" even if the shutter were located between the lens and the scene. Therefore, Applicant asserts that claim 10 cannot be obvious in light of any combination of Lindgren and Bakhle, and that the rejection of claim 10 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 11, the Examiner has stated that Bakhle et al. discloses wherein correcting the open state image signal includes compensating for pixel-to-pixel non-uniformities of the FPA (column 1, line 50 - column 2, line 13).

However, claim 11 is dependent on claim 10, and since as demonstrated above claim 10 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 11 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 11 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 12, the Examiner has stated that Bakhle et al. discloses wherein correcting the open state image signal includes compensating for offsets between the opened and closed states of the shutter (column 1, line 50 - column 2, line 13).

However, claim 12 is dependent on claim 10, and since as demonstrated above claim 10 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 12 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 12 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 13, the Examiner has stated that Bakhle et al. discloses wherein correcting the open state image signal includes compensating for pixel-to-pixel non-uniformities and offsets between the opened and closed states of the shutter (column 1, line 50 - column 2, line 13).

However, claim 13 is dependent on claim 10, and since as demonstrated above claim 10 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 13 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 13 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claims 15-16, the Examiner has stated that all the limitation of claims 15-16 are included in claim 1; therefore, the Examiner has referred to his comments regarding claim 1.

However, as discussed above, no combination of Lindgren and Bakhle can provide all of the limitations of claim 1. Therefore, since all the limitations of claim 1 are included in claims 15-16, no combination of Lindgren and Bakhle can provide all of the limitations of claims 15-16, and claims 15-16 cannot be obvious in light of any combination of Lindgren and Bakhle. Applicant therefore asserts that the rejection of claims 15-16 should be withdrawn, and respectfully requests reconsideration thereof.

Regarding claim 21, the Examiner has referred to his comments regarding claim 2.

However, claim 21 is dependent on claim 16, and since as demonstrated above claim 16 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 21 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 21 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Regarding claim 22, the Examiner has referred to his comments regarding claim 3.

However, claim 22 is dependent on claim 15, and since as demonstrated above claim 15 cannot be obvious in light of any combination of Lindgren and Bakhle, claim 22 cannot be obvious in light of any combination of Lindgren and Bakhle, and the rejection of claim 22 under 35 USC 103(a) should be withdrawn. Applicant respectfully requests reconsideration thereof.

Claims 23 and 24 are new. Applicant asserts that since claims 23 and 24 are dependent on claim 1, and since claim 1 cannot be obvious in light of any combination of Lindgren and Bakhle, claims 23 and 24 cannot be obvious in light of any combination of Lindgren and Bakhle. Applicant respectfully requests allowance thereof.

Applicant believes the above amendments and remarks to be fully responsive to the Office Action of July 21, thereby placing this application in condition for allowance.

Since the current amendments fully implement the recommendations of the Examiner made in the telephone interview of September 2, Applicant believes that the current amendments bring the application fully into compliance with the Examiner's office action of July 21, and that the application in its present form is therefore allowable without further Examination. No new matter is added herein. Applicant requests speedy consideration, and further requests that Examiner contact its attorney by telephone, facsimile, or email for quickest resolution, if there are any remaining issues.

Respectfully submitted,

/Douglas P. Burum, Reg. No. 65,019/

Vernon C. Maine, Reg. No. 37,389
Andrew P. Cernota, Reg. No. 52,711
David A. Rardin, Reg. No. 52,153
Douglas P. Burum, Reg. No. 65, 019
Attorneys/Agents for Applicant

Customer No. 22500
BAE SYSTEMS
PO Box 868
Nashua, NH 03061-0868
Tel. No. (603) 886-6100, Fax. No. (603) 886-4796
patents@vernmaine.com